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Quality Systems Manual for DOT's

Eastern States Consortium HDPEP Program
(CT, DE, DC, ME, MD, MA, NC, NH, NJ, NY, PA, RI, VT, & VA)

Introduction to Quality Control and Quality Assurance Plan

This Quality Control and Quality Assurance Plan (QC&QA Plan) supports the Hancor Corporate Quality System (HQS); and is a brief description of the policies and procedures used by our manufacturing facilities and other support areas during the manufacturing, testing and delivery of our products. A more detailed description of the HQS is available through Hancor's intranet system. The Plant Manager or Quality Representative can access this for anyone interested.

This document will address the procedures used to assure the production of quality corrugated polyethylene pipe. Specifically, this document will address the production of Corrugated Polyethylene Pipe (CPP) meeting the requirements of AASHTO M252, AASHTO M294 specifications. Additionally, this document will address the needs and requirements of the PPI/CCPA 3rd Party certification protocol. These AASHTO specifications cover four basic types of pipe, which are summarized as follows:

- Polyethylene pipe and tubing with corrugated surface both inside and outside (Type C).
- Polyethylene pipe and tubing with corrugated outer wall and a smooth inner liner (Type S).
- Perforated polyethylene pipe and tubing with corrugated surface both inside and outside (Type CP).
- Perforated polyethylene pipe and tubing with a corrugated outer wall and a smooth inner liner (Type SP).

HANCOR conducts numerous tests on its materials and finished products. AASHTO and ASTM require many of the tests. However, HANCOR exceeds the testing requirements of these specification entities. Because of HANCOR's years of experience, these additional tests give a better predictability of how the pipe will perform and provide a greater level of quality assurance.

The quality control and quality assurance testing can be divided into two categories (1) raw material testing and in-process testing and (2) final product testing. HANCOR's record of accomplishment as a provider of quality drainage products is directly related to the quantity and quality of testing performed at the plants and HANCOR's Central Laboratory.

This Quality Control and Quality Assurance Plan and all related documents are supported by HANCOR's top management through the HQS. HQS is a comprehensive quality management system based upon the ISO9001-2000 International Quality Standard. Hancor is certified and registered under the ISO-9001-2000 standard for the corporate office and the two manufacturing facilities in Ohio. The entire company is to follow the HQS system with the corporate quality staff monitoring through audits each facilities quality system. Furthermore, HANCOR management supports the concept of continuous process improvement and the use of statistical techniques to control and assure the quality of all processes that affect the final product.

Plant Leader

Quality Function Leader

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 VM-21 - Cold Temperature Bend
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**Forms (all forms can also be found on the Hancor ITP HQS
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3020-F-1 First Piece Form
 260-44-F-1 First Piece Form
 3660-F-12 First Piece Form

Quality Audits & Resumes

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SECTION 1.

Definitions

- 1.1. **Administrator:** A third party agency designated and authorized by several parties to validate and verify a manufactures product and process to a predetermined set of expectations.
- 1.2. **Conformance:** Compliance with specified requirements.
- 1.3. **Control:** To exercise authority over and regulate.
- 1.4. **Corrective Action:** Measures taken to rectify conditions adverse to quality and to eliminate or prevent recurrence.
- 1.5. **Day or Days:** In measuring time, the term day or days, in this document refers to calendar and not business days.
- 1.6. **Documentation:** Recorded information (electronic or paper).
- 1.7. **Manufacturer:** Any manufacturer that produces HDPE corrugated pipe as defined in AASHTO M252 and M294.
- 1.8. **Non-conformity:** Non-fulfillment of a specified requirement.
- 1.9. **Preventive Actions:** Action to eliminate the potential cause of non-conformity.
- 1.10. **Product:** Corrugated polyethylene pipe as defined in Section 4.2. Product types are corrugated (C), smooth inside (S), and profile (D). Perforated classes are class II, class I, and non-perforated.
- 1.11. **Quality Assurance:** Those planned, systematic, and preventive actions that are required to ensure materials and products will meet specified requirements.
- 1.12. **Quality Control:** Inspection, testing, or examination activities to ensure materials and products were produced to specified requirements.
- 1.13. **Quality Program:** An established, documented system to ensure quality.
- 1.14. **Validation:** The process by which a separate determination is made by a third party to ensure a process or product meets specified requirements.
- 1.15. **Verification:** The process by which a determination is made that ensures the process or product meets specified requirements.

SECTION 2

Management Responsibility and Organization

2.1

Quality Policy.

2.1.1

The introduction to this QC and QA plan summarizes HANCOR's commitment to quality. HANCOR's Quality Policy appears at strategic locations throughout the manufacturing plants. The Quality Policy (see attachment 9 – TAB 3) is available for review by associates. The policy is explained during orientation training so that each associate thoroughly understands the policy.

2.2

Organization

2.2.1

Responsibility and Authority

2.2.1.1

The organization chart, attachment 1 – TAB 3, illustrates the relative authority of those people who manage, perform and verify work effecting quality of product or service.

2.2.1.2

The Quality Function Leader is responsible for the implementation of the HANCOR's Quality System (HQS). Within this system (computer based via Hancor Intranet) all necessary documentation is available to all Hancor associates. This documentation includes AASHTO M252, M294, ASTM test procedures and Hancor Standard Operating Procedures, Work Instructions, Control Plans, and Verification (test) methods. Changes and revision control of these documents are handled through Hancor's Document Control function within the Central Lab.

2.2.1.3

The Quality Function Leader or Management Representative is responsible for chairing a quality system management team. This quality system management team meets at least annually. The agenda includes a review of the effectiveness of the Quality System. Additional agenda items include reviewing:

- Adequacy of resources and training;
- Internal audit and corrective action effectiveness;
- Verification activities;
- Review the adequacy of testing frequencies; and
- Making modifications to the QC&QA plans based on new product development and/or manufacturing process.

2.2.1.4

The Quality Function Leaders office is located in the Central Laboratory at the following address:

Quality Function Leader (Dave Gonso)
433 Olive Street
Findlay, OH 45840
Phone: (419) 424-8377 Fax: (419) 424-8301

2.2.1.5

The plant Quality Control Representative is assigned by the Plant Leader. The Plant Leader is ultimately responsible for product quality. The Plant Leader and/or QC Representative has the following responsibilities:

- Coordinate quality control requirements and activities in the plant facility.
- Ensure adequate training is given to quality and production personnel.
- Provide counseling and guidance on preparation of inspection & test plans.

- Participate in design reviews, which affect their plant.

2.2.1.5

The following table is a list of the Manufacturing Plant Quality Control Representatives Address and telephone numbers for each of HANCOR's production facilities. See Reference document # 1 – TAB 1 for a list of typical products produced at each facility.

| Plant Leader | QC Representative | Address | Phone Number |
|---|-------------------|--|--------------|
| Plant Leader (Dave Markie) | Don Baer | 1 William Donnelly Pkwy. Waverly, NY 14892 | 607-565-3033 |
| Plant Leader (Greg Tewksbury- Interim) | Jason Cram | 30 Precision Drive N. Springfield, VT 05150 | 802-886-8403 |
| Plant Leader (Steve Farrow) | Dan Reddick | 12370 Jackson TR 172 Findlay, OH 45839 | 419-424-8222 |
| Plant Leader (Bert Austin) | Jeff Braun | 5816 Highway 70 East Melbane, NC 27302 | 919-563-3609 |
| Plant Leader (Clark Inniger) | Charlie Groves | 433 Olive St. Findlay, OH 45839 | 419-422-8225 |
| Plant Leader (Irving Howard) | Robert Sears | 1013 West 11 th Ave. Cordele, GA 31015 | 229-273-1081 |
| Plant Leader (Jim Pickering) | Roger Ofill | 140 Vineland Bakersfield, CA 93307 | 661-366-1520 |
| Plant Leader (Marv Griggs) | Dave Barber | 6001 Belmore ST. S.W. Olympia, WA 98512 | 360-943-3313 |
| Plant Leader (Steve Gillespie) | Tim Duncon | 2340 E. US Hgwy 40 Brazil, IN 47834 | 812-443-2080 |
| Plant Leader (Greg Purtle) | Mark Halepeska | 801 Hickey St. Yoakum, TX 77995 | 361-293-6313 |
| Plant Leader (Jeff Leuth) | Todd Buhmann | 1001 Timberlake Road Fairmont, MN 56031 | 507-238-4791 |
| Plant Leader (Rob Pennebaker) | Bill Oakes | Highway 3 Northwest Oelwein, IA 50662 | 319-283-3324 |
| Plant Leader (Al Rush) | Will Davidson | 5695 Highway 61 S Vicksburg, MS 39180 | 601-629-9040 |
| Plant Leader (Ken Gaston) | Doug Marsh | 1 Ulmann Drive Sebring, FL 33870 | 863-655-5499 |

2.2.1.6

The Human Resource group and the Plants maintain job descriptions, including the responsibility and authority with respect to quality.

SECTION 3

Raw Material Identification, Traceability and Testing

3.1

Material suppliers go through a pre- qualification process before materials are used in production. This process includes some of the following actions: **(see addendum 4a –TAB2)**

- a. Supplier provides sample of materials to the Central lab for testing

- b. Suppliers selected and allowed to provide materials provided the above condition is met.
- c. New suppliers product will be closely monitored over the following year(s) to check for consistency. If raw materials are found inconsistent or non-conforming during the year, corrective action requests will be forwarded to supplier. If corrective actions are not acceptable, supplier will be dropped.

3.2

A lot control number or purchase order number traces all incoming materials. Records used to identify lots and their origins are maintained in the Central Laboratory and in the computer system. The following table summarizes the sampling frequency for the various methods of receiving raw material.

| Raw Material Delivery | Sampling Frequency (2) | Work Instruction # |
|------------------------------|--|---------------------------|
| Rail Car (1) | A minimum of one sample from lower portion of rail car compartment. | RM-WI-2 RM-WI-3 |
| Tractor Trailer Truck | One sample per tanker truck provided by truck driver. (safety issue) Hancor employees watches | RM-WI-2 RM-WI-3 |
| Boxes | A minimum of one sample from each box. | RM-WI-2 RM-WI-3 |

- (1) OSHA safety rules must be followed when sampling top compartments of rail cars. If the plant does not have the required safety equipment, then only the bottom compartments will be sampled.
- (2) In lieu of sampling, the virgin suppliers Certificate of Analysis (COA) test data or historical test results based upon statistical analysis may be used. One sample from these lots will be sent to the central Lab for verification testing. When this occurs, random sampling and testing will still be done for Quality Assurance purposes.

It should be noted, that HANCOR uses the term “box” for rail and truck compartments as noted on Form # LAB-F-2 - Attachment 2 in TAB 3). See reference documents 2 & 3 -TAB1 for receiving and sampling of raw materials.

3.3

Each sample is bagged using a 6”x9” baggie and marked with the appropriate lot control number –usually the purchase order number. This identification system is maintained through all phases of manufacturing process to provide 100% traceability. Each baggie is filled at least half way with material from the box or compartment.

3.4

A history file is maintained for a minimum of 5 years at the Central Laboratory and/or Home Office for each material lot. This file contains supplier information, the results of the laboratory testing and additional information.

3.5

Samples of the material are sent to the Central Laboratory where testing is performed to determine the material's physical properties. Every load of HDPE received by the plant is

either sampled by the plant and/or a material Certificate of Analysis (CoA) is provided by the supplier.

For NY, VT, NC and both Ohio plants, the following provisions apply:

- For M252 products produced from a single stream resin, there must be a COA indicating the virgin resin meets the melt index and density requirements of M252. The resin can be used with follow-up verification for the lot.
- For M252 products produced from resin blends, the melt index and density of each component resin must be tested, found to reasonably conform to the COA results, and used to determine the blend ratios. Each blend of resin components establishes a lot, and a new lot is established each time a component resin or a component ratio changes more than allowed by the blend tolerances. The melt index and density of each blend lot must be tested prior to use.
- For M294 products produced from a single stream resin, the virgin resin must be certified to meet the requirements of section 6.1 of M294, either through PPI listing or recognized third party testing. The resin may be used before testing, but the melt index and density must be verified by subsequent testing.
- For M294 product produced from resin blends, only blends certified to meet the requirements of section 6.1 of M294, either through PPI listing or recognized third party testing may be used. Follow-up testing for melt index, density and NCLS must be done for each lot to verify the certification. The component resins and percentages of each in the PPI or third party approved blend must be provided to ESC auditors so that it can be verified that an approved blend is being used to produce the M294 product.

For all other production, one sample of the virgin material from each lot will be sent to the Central Lab for verification testing. Actual test results for melt index and density, instead of CoA data; will be used to establish M252 blend ratios for plants supplying ESC States (NY, VT, NC and both Ohio plants). The CoA results will still be used for production for all other plants unless there is a significant difference in the lab test results from the CoA results. Testing by the Central Lab includes, but is not limited to, the following: (see reference document 4 – Central lab Operations and Scope (SOP 8.1) – Tab1). Material lot# is defined as the P.O. number. The quantity within that material lot is found on the P.O. document and certification documents. These amounts can vary depending upon transportation type (e.g. railcar or tanker).

| Type of Test | ASTM Test Standard (Hancor) Procedure TAB 4 | Test Frequency |
|---------------------------|---|---|
| Melt Index ⁽²⁾ | ASTM D1238 (Lab-WI-10) | Each compartment of a rail car or five random on a box shipment |

| | | |
|------------------------|--|--|
| Density ⁽²⁾ | ASTM D1505 (LAB-WI-14) | Each compartment of a rail car or every 5 th box of a box shipments |
| Flexural Modulus | ASTM D 790 (Lab-WI-08) | Random ⁽³⁾ |
| Tensile Strength | ASTM D 638 (Lab-WI-17) | Random ⁽³⁾ |
| ESCR or NCLS | ASTM D1693 or D5397 (Lab-WI-12 & Lab-WI-05) | Random ⁽³⁾ |
| Carbon Black | ASTM D1603 (Lab-WI-02) | 5 random samples from each shipment (if necessary) ⁽⁴⁾ |

Notes:

1. Supplier certification as to the physical properties may be used to determine acceptability of the material **except as noted in section 3.10 below**.
2. Melt Index and Density are the primary tests that are done to accept or reject a material. If these properties are within specification, the other properties such as tensile strength and flexural modulus will also be in specification. (see Phillips Petroleum report).
3. Not only are these properties randomly checked, but also results from the Izod test may trigger the need for the ESCR and tensile strength testing.
4. When the raw material is a carbon black concentrate, this test is performed.

3.6

The preceding tests are performed in accordance with the requirements of ASTM D3350 as designated by AASHTO M252 and AASHTO M294. This testing is performed to assure that the pipe material meets the cell classification as required by the appropriate specification. Once per month a sample will be pulled from a process producing AASHTO product and that material will be tested for the complete cell class properties. If resin suppliers/grades of material change during the month those samples will be submitted also. Test results are available for review upon request by customers (DOT's).

A general description of these raw material tests are summarized as follows:

3.6.1 Density

Density is the first digit in the cell classification system established by ASTM D3350. The density test is performed in accordance with the ASTM D1505 or equivalent as described in methods A or B of Test method ASTM D792.

3.6.2 Melt Index

Melt index is the second digit in the cell classification system established by ASTM D3350. The melt index test is performed in accordance with the ASTM D1238.

3.6.3 Flex Modulus

Flexural modulus is the third digit in the cell classification system established by ASTM D3350. The flexural modulus test is performed in accordance with ASTM D790, except some modification, which are specified in ASTM D3350.

3.6.4 Tensile Strength

Tensile strength is the fourth digit in the cell classification system established by ASTM D3350. The tensile strength test is performed in accordance with ASTM D 638, except some modifications specified in ASTM 3350.

3.6.5 Environmental Stress Crack Resistance (ESCR/NCTL)

ESCR or NCLS is the fifth digit in the cell classification system established by ASTM D3350. The ESCR or NCLS test is performed in accordance with ASTM D 1693 or ASTM D5397.

3.6.6 Percentage of Carbon Black

The carbon black content of a given cell classification is designated by the letter “C” at the end of the cell classification system established by ASTM D3350. The percentage of carbon black is determined in accordance with ASTM D 1603. The carbon black percentage is based on a percentage of total weight. Each production shift performs blender calibrations that include verifying that the carbon concentrate going into the virgin blend is at the proper percentage that will provide the required carbon percent of 2 – 5 % in the finished product. The final product is also, randomly tested to assure proper carbon black content.

3.7

As raw material tests are performed, the results are logged onto the appropriate quality form (i.e. LAB-F-2) – Attachment 2 in Tab 3. This form is an electronic form maintained in a database.

3.8

If the raw material meets the requirements as identified above, the material is passed for manufacturing to AASHTO M252 and AASHTO M294 as appropriate. A computer is used to forward the test data to the manufacturing plant and to store the test results.

3.9

If any lot of raw material is found nonconforming, the material may be re-sampled and re-tested. If the material is still found nonconforming, the material is rejected back to the supplier. The material supplier is required to provide a corrective action response back to Hancor. Hancor may elect, depending upon the severity and/or frequency of rejects to audit the supplier. Section 10 below summarizes non-conforming responses. See reference document 5 – Control of Non-Conforming Product (SOP 8.5) –TAB1.

3.10

As test data of material suppliers is gathered and subsequently analyzed for variation and adherence to specification, those suppliers who show consistent results will not be tested by the Central Lab on a 100% inspection basis but the results supplied by the supplier on their Certificate of Analysis (CoA) will be used to accept or reject a lot. The Central Lab will perform skip lot sampling of those suppliers for verification purposes. All virgin material lots from the NY, VT, NC and both Ohio plants will be sampled and sent to the Central lab for verification of Melt Index and Density.

3.11

A Brief description of the material blending process:

Raw material blends are formulated based upon the test results of the individual components. Percentages are assigned to each component so that the average material characteristic of the blend (i.e. melt index and density) falls within Hancor's specification and/or AASHTO's cell classification. For Eastern States Consortium requirements (NY, VT, NC, OH-HT and OH SP **plants** only) each time an AASHTO product blend number changes that blend will be sent to the Central Lab.

Pipe and fittings products can be made from multiple lots of materials. Each lot may have different characteristics such as density and melt index. Pipe and fittings may have different material formulas that provide the best processing capabilities and impart the most optimum material characteristics for those pipe and fittings. Two or more materials are fed through volumetric hoppers. Each hopper is set up to feed a certain percentage of material based upon the material formulation. All hoppers feed their materials into a common blender that mixes all materials uniformly. This material is then conveyed through vacuum lines to a dryer that removes any surface moisture. From the dryer the material is conveyed to the extruder hopper where it is converted into pipe or fitting products. It is critical that the percentage of each material is maintained so that the formulation remains consistent throughout the production process. Therefore, blenders need to be checked periodically to determine whether the individual hoppers are putting out the same percentages as when the original formula was set up. The current blender calibration check process is done every shift and the blender calibration worksheet is filled out and becomes a quality record. In the event that the blender percentages change the person calibrating the blender notifies production supervisor and corrective actions take place. If the percentages change so that the formula specification ranges are exceeded, the product is put on hold and samples submitted for pipe performance testing; and also material samples sent to the Central lab to verify the material still meets the AASHTO cell classification requirements by testing for melt index and density.

SECTION 4

Finished Product Identification, Traceability and Testing

4.1

Once the material has been approved for use, the manufacturing plant raw material control person sets up the blending equipment to produce a material blend (i.e. a virgin lot of raw material(s) and black concentrate). A raw material blend number is assigned to each blend of materials. A copy of the blend record is maintained and can be accessed in the database for all plants. Once per month the raw material control person will send to the Central Lab a sample of material blend along with the blend sheet so that the Central Lab can verify the material properties meet the AASHTO requirements. If resin suppliers/grades of material change during the month those samples will be submitted also. Test results are available for review upon request by customers (DOT's). The Central Lab will notify the plant when there is an issue, otherwise the results will be documented in a spreadsheet and saved for future reference.

4.2

All parts and products are designed to meet AASHTO specifications and other applicable standards. HANCOR permanently marks the finished products with the company name, pipe size, product description, and a date code. Part number, date code and vendor code identifies

all other components. A typical example of a date code identification is “0528972UU”, which represents a product, manufactured May 28, 1997 on the second shift at the corrugated line (UU) in the Yoakum, Texas manufacturing plant. **See attachment 7 – Date Code Marking print – TAB 3**

4.3

Each shift and production line documents the material used (as identified by the blend number) during the shift. The First Piece Verification form as shown in **TAB 5** includes information to document the date code of the product and the raw material blend used for that product during the manufacturing process. Therefore, a system is in place to account for 100% traceability of the material used to manufacture a particular product and allow for the review of dimensional and performance tests. The date code that is marked on the product is the manufacturing date that is recorded on the operators log.

4.4

During production a minimum of the following checks are performed at the manufacturing plant: See attachment 3 – A typical pipe control plan for more detail in TAB 3.

| Pipe Production | | |
|---------------------------------|---|----------------------------------|
| Test Description ⁽¹⁾ | Hancor Verification Method (VM) - TAB 4 | Frequency of Test ⁽²⁾ |
| Weight per foot | VM - 1 | 1 sample/hr – CC ⁽³⁾ |
| Inside diameter | VM - 3 | 1 sample/shift |
| Outside diameter | VM - 4 | 1 sample/ shift |
| Liner flatness | VM - 5 | 1 sample/shift |
| Perforation pattern | VM - 7 | 1 sample/shift |
| Perforation Inlet area | VM - 7 | 1 sample/shift |
| Liner thickness | VM - 9 | 1 sample/ hour- CC |
| Sidewall % variation | VM - 10 | 1 sample/ hour -CC |
| Crown Thickness | VM - 9 | 1 sample/ hour -CC |
| Product Length ⁽⁴⁾ | VM-13 | 1 sample/ shift |

Note:

1. Depending upon product type, manufacturing process and design, other dimensional tests may be included for testing to assure product quality.
2. These test frequencies may be increased or decreased if determined necessary because of statistical quality control calculations unless decreasing would violate a customers requirements. Frequencies will not be reduced below customer requirements unless agreed to between customer and manufacturer.
3. **CC** is equal to control chart. Product specification control limits or statistically derived control limits may be used. Weight per foot, minimum liner thickness, sidewall % variation and minimum crown thickness are charted each hour on the control chart. The first piece form documents results that are done each shift unless otherwise noted.
4. The product length measurement is conducted at ambient room temperature due to extra long measurements (20 feet – 40 feet) of our product offerings. The process, including mold blocks, was designed to account for shrink rates of plastic after processing. Also, the products are cut to certain dimensions to allow for shrinkage and

to assure that the minimum length will not violate the customer requirements. Hancor's Central lab studied the shrink rates of product to assure the design criteria and manufacturing cut instructions were sufficient.

4.5

These tests, described in section 4.4, above, have been identified as "Critical to Quality" for two reasons. First, some of the dimensional tests will predict the finish product performance capability (i.e. impact resistance and parallel plate strength). Secondly, some tests are required by specification (i.e. ASTM, AASHTO, etc.). The results of these tests and measurements are recorded on the First Piece Verification Form - TAB 5. The following is a brief description of the tests described in section 4.4:

4.5.1 Weight

The weight per linear foot is checked at a minimum of every hour of production. This is an important parameter, since it is indirectly related to the pipe stiffness.

4.5.2 Thickness

Thickness is checked at a minimum once every hour of production. The procedure for this quality control check is performed in accordance with ASTM D2122. Hancor personnel checks several locations of the pipe profile to assure that minimum thickness are met or exceeded. Among the thicknesses checked are the crown thickness, liner thickness, root thickness, and sidewall thickness.

4.5.3 Liner Flatness

Hancor associates checks the liner flatness of the finished produce. The flatness of the liner refers to the liner rippling. The procedure for this quality control check is performed in accordance with ASTM D2122. This test checks for excessive liner rippling and assures the hydraulic capacity of Type S and Type SP products.

4.5.4 Diameters

Diameters are checked routinely. The outside diameter and inside diameters are checked once every shift during production. The procedure for this quality control check is performed in accordance with ASTM D2122.

4.5.5 Marking Verification

Marking verification is checked at a minimum once per shift of production. This procedure is performed to maintain compliance with appropriate ASTM or AASHTO specification. All pipes are required to have marking permanently affixed at intervals no more than every 3.5 m or 11' 5". The following is the minimum required information: Manufacturer or trademark, Nominal size, Specification designation and Date manufactured.

4.6

In addition to the testing described above, a number of tests are performed on the finished product. These tests are as follows: (**See reference document 6 – In-Process Quality Assurance Testing (GEN-WI-1)** – TAB1 for additional detail. M252 test and their frequencies are, also, mentioned in GEN-PROD-WI-1 document). See Control Plans for more explanation.

When products are produced in accordance with AASHTO specifications but use non-virgin raw materials and the product is accepted by the customer (i.e. DOT) all performance property tests and material properties still need to meet the requirements of AASHTO (except for virgin vs non-virgin description).

| Test Description (3) | VM # TAB 4 | Test Standard (2) | Test Freq. –QC (4) min. requirements | Test Freq. – QA (4) min. requirements |
|-----------------------------|---------------|--------------------|---|--|
| Pipe Stiffness @ 5% | 19 | ASTM D 2412 | Blend change or product control plan change | Per production run or maximum 2 day lot size |
| Pipe Flattening @ 20% | 19 | ASTM D 2412 | same | Same |
| Cold Temperature Impact | 17 | ASTM D 2444 | same | same |
| ESCR | 38 | AASHTO M294 | | One time per week per product run |
| Marking Verification | 14 | AASHTO M294 | 1 per shift | |
| Visual | 15 | AASHTO M294 | 1 per shift | |
| Alignment Test | | AASHTO M294 | | One time per week per product run |
| Joint Integrity | 37 | AASHTO M294/M252 | | One time per week per product run |
| Elongation | Lab-WI-7 | AASHTO M252 type C | | One time per week per product run |
| Low temperature flexibility | 21 | AASHTO M252 type C | | One time per week per product run |

Note:

1. These test frequencies may be increased or decreased if determined necessary because of statistical quality control calculations. Frequencies will not be reduced below customer requirements unless agreed to between manufacture and customer.
2. The test standards used are those referred to in the appropriate AASHTO standards.
3. The test description typically is for Quality Control testing. However, for AASHTO certification testing the sampling frequencies and testing conditions are different. Refer to the control plan and the reference document #6 for more information.
4. These are minimum test frequency requirements. The plant has the option of increasing testing as they deem necessary. QC tests are done as production is being run. QA test are done once production is over or a 2 day lot is established. QA tests are done with condition times per the standard. QC test are done with modified conditioning times. See GEN-WI-1 for QA test info in TAB 1 and control plans for QC testing info in section 2 Attachment 3 – TAB 3 of the manual.

4.7

The testing described in the preceding Sections 4.4, 4.5 and 4.6, are performed in accordance with the requirements of ASTM and AASHTO M294 for diameters 12" – 60" and M252 for diameters 3"- 10". These have been identified as "Critical to Quality" test for two reasons. First, some of the dimensional tests will predict finished product performance capabilities (i.e.

impact resistance and parallel plate strength). Secondly, certain tests are required by specification (i.e. ASTM and AASHTO). The following is a brief description of some of the more involved testing standards noted in Section 4.6.

4.7.1 Cold Temperature Impact Testing

Impact testing varies from once every hour to once every shift of production. The frequency of testing is dependent upon the diameter of pipe. The procedure for this quality control check is performed in accordance with ASTM D 2444. In the case of AASHTO M 294 products, the samples to be tested are left in a freezer for a minimum of 24 hours at 25 degrees Fahrenheit. The sample is then tested within 60 seconds from the time it is pulled from the freezer.

4.7.2 Pipe Stiffness (@ 5% and 20% deflection)

Parallel plate tests are performed at a minimum once per shift of production. The procedure for this quality control check is performed in accordance with ASTM D2412. Hancor personnel checks several samples of the pipe being manufactured. This testing involves testing the pipe for both the pipe stiffness at 5% deflection and checking for splitting at a 20% deflection at 70 -77 degrees F room temperature. Additionally, at 20% deflection the pipe is required to continue carrying a load. Attachment 5 is an example of the pipe stiffness test equipment printout.

4.7.3 Environmental Stress Crack Resistance (ESCR)

Environmental stress cracking tests are performed following a modified version of ASTM D1693. This test is done for certification testing.

4.8

This finished product testing is performed at the manufacturing plant's laboratory or the Central Laboratory. In those cases where the finished product testing is performed at the manufacturing plant, samples are submitted to the Central Laboratory periodically for quality assurance and audit verification.

4.9

Once the testing is performed, the test data is stored. This stored data is referenced by the date code (i.e. plant, shift, production line and date). This information is stored for a minimum of 5 years. Detailed information regarding this documentation is contained in Section 7. Test data may be stored on computer disk or paper copy. Form Gen-ST-7 or GEN-F-5 (reference document # 7 or 7a in TAB 1) is used by the plants and the testing lab to communicate the submittal of samples for testing and the recording of the results back to the lab and plant.

4.10

Hancor pipe is connected using an integral bell formed during production. In those products where this does not occur other types of connectors or fittings are used. See Ref #8 in Tab 1 for details concerning these other fittings. **For fitting suppliers they will be required to maintain records showing fitting products supplied to Hancor meet M252/M294 resin requirements.**

SECTION 5

STATISTICAL QUALITY CONTROL

Production associates conduct first piece inspections and the data is entered into the computer. Product performance (i.e. Pipe Stiffness) is also entered into the computer. Once this data is entered the plant leadership can use statistical tools such as averages, standard deviations, histograms, etc to determine how the process and product is doing compared to specifications. Decisions such as changing weight per foot, material properties, process properties, etc can be outputs of those decisions.

Production associates also use control charts to help reduce part to part variation. These charts monitor weight per foot, crown minimum thickness, liner minimum thickness, side wall to side wall variation. These characteristics are considered critical to quality since they affect the end performance of the pipe.

Hancor's Engineering and Quality department also has access to this data. The engineers will use this data much as the plants do but will also compare plant to plant, tooling sets, and production lines data to determine where opportunities for improvement lie, for problem solving and for New Product Development.

Material testing data is handled in much the same way. Supplier data is looked at for consistency within production lots and also between production lots. Supplier to supplier data is also compared to determine which suppliers will be preferred over others.

Purchased statistical software is used to analysis data. Hancor is currently developing its own proprietary software to analysis data.

SECTION 6

Testing Equipment Inspection, Maintenance and Calibration

6.1

All measuring & test equipment critical to maintaining quality is identified so that the operators know whether the instrument is available for use. Calibrations are done using standards that are traceable to the National Institute of Standards and Technology (NIST). Master gages and working standards are available for calibrations.

6.2

The Maintenance Supervisor or other Plant Leader designee is responsible for identifying those production and quality control gages used by the plant and placing them under a calibration control system. When new gages are purchased or when parts of gages change (i.e. transducers and cables for Ultra-Sonic gages) they will be identified and placed into the calibration system.

6.3

All test equipment is "tagged" to identify its calibration status, to specify the next calibration date, and to identify the calibrator.

6.4

It is the responsibility of everyone using the measuring and test equipment to verify that the calibration status is correct. In case of accidental damage or in case of any irregularities, each user of the equipment alerts the Central Laboratory immediately. The Central Laboratory will determine corrective action measures.

6.5

Specific written procedures and/or instructions are used for each “in house” calibration. These calibrations are performed to a nationally traceable standard unless none exists.

6.6

Preventive maintenance is performed on all measuring and test equipment in accordance with manufacturers’ specifications where applicable.

6.7

Currently test equipment is calibrated in accordance with the following table:

| Equipment | Internal Test Frequency⁽¹⁾ | External Test Frequency⁽²⁾ |
|---|--|--|
| Vernier Caliper | 1/ 6 months | NA |
| Micrometers | 1/ 6 months | NA |
| Ultra Sonic thickness gage w/ transducer | 1/ 6 months | |
| Parallel Plate | NA | Annually |
| Tape Measure | 1/ 6 months | NA |
| Thermometers | 1/ 6 months | NA |
| Pi Tapes | 1/ 6 months | NA |
| Gage Blocks (master) | NA | 3 years |
| Gage Blocks (working Standard) | 1/ 6 months | NA |

Notes:

1. Internal test frequency refers to the frequency of in house calibration performed by Gage Calibration specialists.
2. External test frequency refers to the frequency of the calibration performed by an independent calibration service or central lab auditor.

6.8

Once in house testing is performed a sticker with the date is placed on the equipment indicating the successful completion of calibration testing and date of calibration testing.

6.9

Equipment not indicated in the preceding table is calibrated annually, at a minimum.

6.10

Calibration records and maintenance records are available for review by internal and external auditors. External Auditors may ask to witness calibrations on selected instruments during their audits.

SECTION 7

Quality Control Personnel Qualifications, Training and Experience

7.1

The Corporate Human Resource Department and/or the Plant Leader is responsible for coordinating all training and for maintaining all records pertaining to training at either the corporate office or Plant office.

7.2

As part of the orientation process, all new employees receive the following instructions from either the Corporate People and Organization Department or Manufacturing plant.

- **Safety** - Before starting work, each new employee is instructed in plant safety procedures.
- **Quality System Overview** - Topics covered include procedure manual, and understanding the quality policy.
- **Skill Instruction** - To acquire the proficiency to perform tasks at the speed and quality level required. This skill instructions include initial training with a shift leader. The employee then receives on the job training under supervision by a lead employee for 2-3 weeks. Performance reviews are performed at 30 and 90 days intervals after employment starts.

Instruction includes the following:

- Review of and practice in test procedures
- Operation of test equipment
- How to perform quality and process calculations
- Filling out production and quality forms
- Use of Control plans

- Operation of production equipment
- Problem solving process and quality problems

- **Location and Use of Work Instructions** – work instructions are provided to the plant and lab personnel so that they may perform their tasks consistently. These Work Instructions are provided in hard copy and also on the Hancor Intranet.
- The plant and Central Lab maintains training records to show that individuals have been trained on certain tasks pertaining to their job(s). **Documentation will be kept to show when initial training has been done, yearly competency reviews, and when revisions to test methods/procedures have been done. These documents will also show hand written signatures/initials of the trainer and trainee.**

7.3

The Plant management will periodically review training needs of plant, office and lab associates at least annually to assure that all associates have the skills necessary to perform their jobs correctly. Additionally, during process quality audits associates skills will be reviewed.

7.4

The Plant Management screens all applications pertaining to plant jobs to ensure that all personnel are adequately qualified based on appropriate skills assessment, education, training and/or experience required.

SECTION 8

Product Handling, Storage and Delivery

8.1

Proper handling is carried out to ensure that incoming parts, in-production products, and finished products are protected from damage.

8.2

Individual areas such as receiving warehouse, production, and yard have procedures for proper storage of product. Specific customer storage procedures are also used.

8.3

The product delivery department is responsible for delivery of products to the customer. Additionally, the product delivery department ensures that the product reaches the customer in good condition. Attachment 6 – **TAB 3** contains a Technical Bulletin titled "Job Site Receiving and Handling of HANCOR pipe", which is distributed with shipments of product.

SECTION 9

Quality Control Inspection and Testing Records

9.1

Quality records are stored in a manner that facilitates retrieval for the period of time specified in Paragraph 7.3.

9.2

Each department and/or plant is responsible for maintaining adequate quality records to demonstrate required quality and effective system operations.

9.2.1

Attachment 2 – TAB 3 contains an example of the materials testing quality records (LAB -F-2). These records document the lot control number or purchase order number of the material used in the manufacturing process, as well as test results described in section 3.5.

9.2.2

The 1st Piece Inspection forms" shown in TAB 5 is used to record a variety of production related and test data. This document is instrumental in tracing the material to the product. This document records the lot control number or purchase order number (see Blend Number) and the date shift and line number (a.k.a. the date code). Note: Different production processes such as blow molding, fabrication of fittings, and the different processes to make pipe may have different 1st Piece forms specific to their process.

9.3

Production records are maintained for a minimum of 5 years.

9.4

Internal quality audits serve to ensure that the necessary records are being generated, utilized and retained and to identify improvement opportunities.

SECTION 10

Nonconforming Product and Corrective Action

10.1

All incoming and in-production nonconforming materials and products are quarantined until a final disposition notice is issued. See reference document # 5 – Control of Non-Conforming Product (SOP 8.5) in TAB 1 for additional information.

10.2

Dispositions are issued based on the ability to meet customer requirements. Quality, Manufacturing, Engineering, and Sales Departments will undertake a thorough investigation of the nonconforming products.

10.3

Corrective action requests may be triggered by one or more of the following actions:

- **Plant Quality Audit** - A corrective action may be initiated due to the Auditor finding a quality system breakdown or when a product is tested and found non-compliant.
- **Customer Concern/Complaint** - A corrective action may be initiated as a result of a filed complaint or failure that is caused by the product.
- **Preventative Actions** - Resulting from Engineering, Production, Sales or Quality Control Department input.
- **Third Party System Surveillance Audit** – Auditor may find a product out of compliance or a system process not working.
- **Incoming Material inspection process** – Material that is tested and rejected may cause a request of the supplier to determine root cause and what action to be taken to prevent rejection again.
- **In-Process pipe testing** - Chronic problems will require corrective action.

10.4

The above referenced corrective action requests have their corresponding procedure(s) for resolution. The corrective actions can be taken in the form of a C.A.R. (Corrective Action Request), which is a process used for relatively simple solutions or the 8D process, which is used for more complex issues and may include upper management input and approvals. Plant keeps copies of corrective action reports for follow-up activities and reviews. Anytime a product is found to be non-conforming there are several possible outcomes or dispositions for the product affected. They are as follows: scrap all product and grind; and re-class product to another non-AASHTO market (the AASHTO designation would be obliterated from each product). See reference document #'s 5 and 6 in TAB 1 for more detail relative to resolving and disposing of non-conforming product.

10.5

The QC & QA department will receive copies of all corrective action requests and is responsible for follow-up to ensure that corrective action is in place. If necessary, internal audit frequencies are adjusted accordingly to verify corrective action implementation and effectiveness.

SECTION 11

Customer Service, Quality Assurance and Internal & External Quality Audits

11.1

Internal quality audits are performed in each plant and/or department at least once a year to monitor the effectiveness of the overall system. All quality-related activities comply with written procedures. Audit frequency is scheduled, and the schedule is adjusted to give heightened priority to potential problem areas.

11.2

The internal auditor is independent of the area audited and may be accompanied by a representative of the area audited. Internal auditors may be contracted from outside the company or come from another plant.

11.3

Internal Quality Audits are periodically carried out in accordance with the established Quality Audit Procedure. The Quality Function Leader must approve all auditors. A list of approved auditors, auditor qualifications, and the Central Laboratory will keep audit schedules.

11.4

In addition to the testing described in Section 3, the Central Laboratory audits finished products, produced from each of the manufacturing facilities. Randomly selected samples are sent to the Central Laboratory periodically and subjected to a range of testing.

11.5

This “cross-check” assures that the products meet the required performance standard of the governing specification, the manufacturing facility is performing these tests correctly, and the calibration of the test equipment is correct.

11.6

Copies of the results of these quality audits are mailed to the manufacturing facility. The original quality audit is kept on file at the Central Laboratory.

11.7

If any product does not conform to the specification requirement, the manufacturing plant is immediately notified by telephone. The product is quarantined and the procedure described in Section 8 is followed.

11.8

The Customer Service Department handles and directs all inquiries from customers regarding ordering, service, application, and return policies of Hancors drainage products. Customer Service will notify the branch shipping plant and the Central lab when customers specifically request product certifications (test reports). Certifications and test reports will be provided to the customer upon request.

11.9

The Customer Service Department establishes and maintains documented customer service procedures. These procedures are amended and/or additional procedures created when specified in new contracts and/or purchase orders.

11.10

Quality Assurance Plan

This includes a comprehensive quality assurance testing program. See reference document # 6 – In-Process Quality Assurance Testing (GEN-WI-1) in TAB 1 for more detail.

11.10.1

Quality Assurance sampling will be conducted following the guidelines set forth on the GEN-WI-1, In-Process Quality Assurance Testing --- Reference document # 6. In addition to Hancors QA sampling and testing, samples of raw materials and finish product may be taken by customers or customers testing labs. Also, the customers testing lab or specifying agency may ask for samples to be sent to another lab (3rd party) for testing purposes.

11.10.2

Each sample from a production run is tested to determine the finished product performance requirements as described in Sections 4.4 and 4.6 of this Quality Control and Quality Assurance Plan. When applicable, perforation dimensions will be checked.

11.10.3

Production runs include all product manufactured under conditions of production that are considered uniform. Any production run exceeding one week will be considered an additional production run.

11.10.4

Quality Assurance test reports will be signed by the laboratory technician performing the test and certified by the Plant Quality Leader as being correct. If all product requirements are met, the quality assurance test report will include a statement indicating, "the samples have been tested in accordance with specifications and that all requirements have been met."

11.10.5

Quality Assurance test reports will be kept for a minimum of 5 years. These test reports indicate the samples tested by the date code of manufacture. Again this date code is used to trace the product back through quality assurance test, quality control tests, dimensional checks during production and the raw materials used to manufacture that sample and date code of production.

11.11

It is acceptable for 3rd Party Auditors, state DOT auditors or their representatives to conduct unannounced quality product and facility audits. The external auditors are responsible for asking Hancor and those plants for their normal working hours, holiday downtime, and any other normally scheduled plan shutdown schedules prior to initiating an audit schedule. If this information is not asked for then Hancor has no liability connected with costs associated with the audit.

11.11.1

Each manufacturing facility will maintain records of all External Audits (ESC audits, DOT audits, 3rd Party audits, etc) along with any non-conformances and associated corrective actions taken after the audits.

